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MEASUREMENT OF THE DRIFT OF IONIZATION IRREGULARITIES
IN THE E^y REGION OF THE IONOSPHERE AT SIMULTANEOUS CONTROL
OF REFLECTED RADIO WAVES' POLARIZATION

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INTRODUCTION

Investigations of the drift of ionization irregularities of the ionosphere were conducted at a series of points beginning with 1948 - 1950. Applying mainly the method of signal reception at three scattered points, the velocity and the direction of the drift are determined. It must be noted that the motion of ionosphere irregularities apparently reflects incompletely the atmosphere circulation at respective altitudes. It follows from theoretical calculations, that the ionized formations drift with wind velocity in the direction of the magnetic field. Only observations of meteor trails allow the obtaining of systematic data on the wind regime. However, these data refer to a rather narrow altitude range (about 90 - 105 km).

The reflection of radiowaves from the E-region of the ionosphere takes place mostly at 120 km. If we analyze the system of electrodynamic equations for an incompletely ionized gas, we may establish that notable deflections of the movement of irregularities from those of the neutral component are possible at that height. It was shown in ref. [1], that the region of the ionosphere in the 110-130 km range

④ [* IZMERENIYE DREYFA NEODNORODNOSTI IONIZATSII V OBLASTE E IONOSFERY PRI ODNOVREMENNOM KONTROLE POLARIZATSII OTRAZHENNYKH VOLN.]

is transitional in its own way. Below that region we may make use of the equation of the geostrophic wind, and above — of a dynamo — region for which a substantial influence of electrodynamic effects is characteristic.

The character of the fluctuation of signals received at scattered points may be strongly distorted on account of polarization fading of the ordinary and extraordinary components. To exclude such effect, it is usually recommended to conduct measurements in the frequency of 2.2 ± 0.2 mc/s, i. e. a frequency near the gyromagnetic, when the extraordinary component is absent. The following up of this recommendation implied the requirement of using stations of tens of kw power in the pulse for the obtention of drift data in daytime, a strong absorption being present near noon time. Consequently, an experimental verification of the reliability of the results obtained at higher frequencies is required.

The investigations of drift irregularities are included in the IGY program of scientific observations during the period of the quiet Sun (1964 — 1965).

Measurements of polarization of radiowaves reflected from the E-region of the ionosphere were regularly conducted at Khar'kov's Polytechnical Institute during the period 1959 — 1960. The drift was measured either in the presence of only one component, or at exclusion of one of the components whenever two were present in the reflected signal.

Some of the results are brought out in the present work, and recommendations are made in regard to practical implementation of drift measurements in the absence of a radiopolarimeter. The instrumentation and the method of measurements are examined in ref. [2]. -

* * *

1. INVESTIGATIONS OF LIMIT POLARIZATION OF RADIOWAVES REFLECTED FROM THE E-LAYER OF THE IONOSPHERE.

The limit polarization of vertically ionosphere-reflected radiowaves was studied in the 2 — 6 mc frequency range in the course of 2 — 5 -minute sessions. The obtained 200 — 500 polarization ellipses were processed and averaged by the respective parameters, obtaining a single hourly value. The observation interval varied according to the state of the ionosphere and interference level.

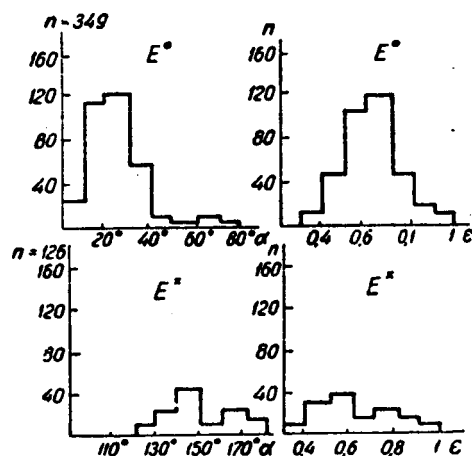


Fig.1.- Histograms of distribution of axes' correlations and inclination angles of main axes of polarisation ellipses, corresponding to the ordinary and extraordinary components, reflected from the E-layer. The number of cases is in ordinates, and the angle α , computed by the clock arrow from the Northerly magnetic direction to the main axis of the ellipse, is in abscissa; ϵ is the axes' relation of the polarization ellipse.

The results of investigations of the polarization are plotted in Fig.1. When plotting histograms, the data obtained in days with disturbed ionosphere were excluded, as also the so-called cases of quasi-steady polarization, conditioned by simultaneous presence of both magnetoionic components. This was done in connection with the fact that the reflections from perturbed ionosphere are characterized by a sufficiently small exis ratio [2], and that the polarization parameters vary then substantially from one perturbed day to another. The cases of quasi-steady polarization also often have a small axes' correlation and are quite unsteady in time. Therefore, these two phenomenas will conceal to a certain degree the seasonal, daily and other parameter variations of the polarization ellipse.

The results of observations (Fig.1) show that the elliptical polarization of ionosphere-reflected radiowaves is the most-frequently encountered one.

The relationship of the axes of the ordinary magnetoionic component varies most frequently in the 0.6 — 0.7 range, and that of the extraordinary — about 0.5 to 0.8. The axes relation, computed according to the magnetotonic theory, taking into account the diffraction propagation mechanism, varies for the conditions of the city of Khar'kov within the 0.46 — 0.8 range.

The inclination angle of the main axis of the polarization ellipse of the ordinary wave lies in the 0 — 80° interval, and that of the extraordinary wave — in the 120 — 180° range. Often, the main axis of the polarization ellipse of the O-component is situated in the 10 — 30° angular range, and that of the X-component — in the 140 — 170° range., i. e. the polarization ellipses are situated about around the northerly magnetic direction.

The data brought up characterize the limit polarization of only one magnetoionic component, selected with the aid of a radiopolarimeter and of receiving suppression system.

Measurements conducted in Khar'kov allow the ascertaining of the daily (Fig. 2) and seasonal (Fig. 3) variations of parameters of the polarization ellipses. As may be seen from Fig. 2 the polarization parameters of the ordinary component reflected from the E-layer, are

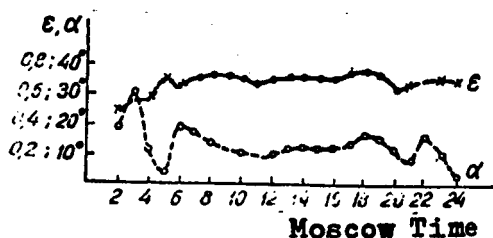


Fig. 2. Daily variations of the parameters of the polarization ellipse of radiowaves, reflected from the E and E_c - layers of the ionosphere. The dashed parts of the curves characterize the variations of the polarization parameters of reflections from the E_c -layer

sufficiently steady in daytime, but substantial variations of the angle of inclination and eccentricity of the polarization ellipse are observed at sunrise and sunset periods.

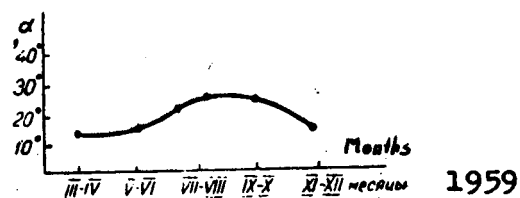


Fig. 3. - Seasonal variations of the angles of inclination of the main axes of the polarization ellipse corresponding to the ordinary component, reflected from the E-layer.

It must then be noted also, that the quasi-period of short-periodical variations of polarization ellipses' parameters ranges from 10 to 70 sec, the magnitude of ratio deflections of axes and inclination angles of main axes from the mean arithmetical respectively reaching 15 and 10%.

The data obtained in 1959 allowed to reveal seasonal variations in the inclination angle of the main axis of the polarization ellipse of the O-component reflected from E-layers. A notable increase in the inclination angle toward summer is apparently explained by either a true variation of collision frequency at the level defining the limit polarization, or by the variation of level height.

2. MEASUREMENTS OF THE DRIFT OF IRREGULARITIES IN THE E-REGION OF THE IONOSPHERE.

Measurements of the drift of irregularities were conducted monthly during 6 to 10 days. Each time signal polarization control was effected with the aid of a polarimeter prior to the beginning of registration.

The results of measurements completed in the years 1959 and 1960 are plotted in Figs. 4 and 5. The prevailing direction of drift is NE in all seasons (Fig. 4). The drift velocity varies to 160 m/sec (Fig. 5). The methods of calculations of the values of velocity (correlation and similarity of signal fluctuations) does not practically allow to compute very low velocities; that is why the lower limit of velocities in Fig. 5 (20 m.sec) has a somewhat conditional character. A certain increase in velocity is observed in the autumn-winter period. It is possibly linked with the fact, that the height of the E-region of the ionosphere at that time of the year is usually somewhat increasing.

It is well known that the gravitational and thermal effect of the Sun causes the appearance of 12-hour wind components. Such wind is observed at the ground with an amplitude of a few tens of cm/sec.

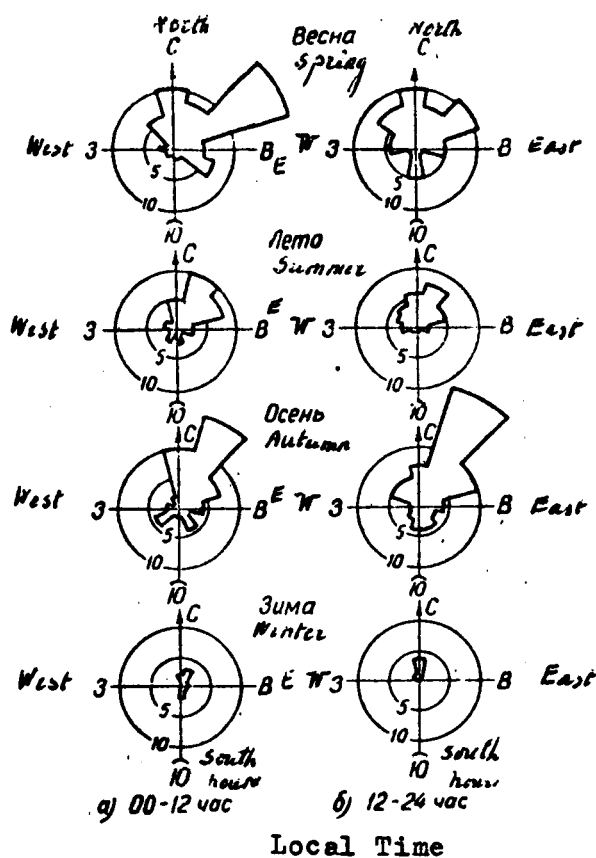


Fig. 4. Histograms of distribution of drift directions in the E-region of the ionosphere

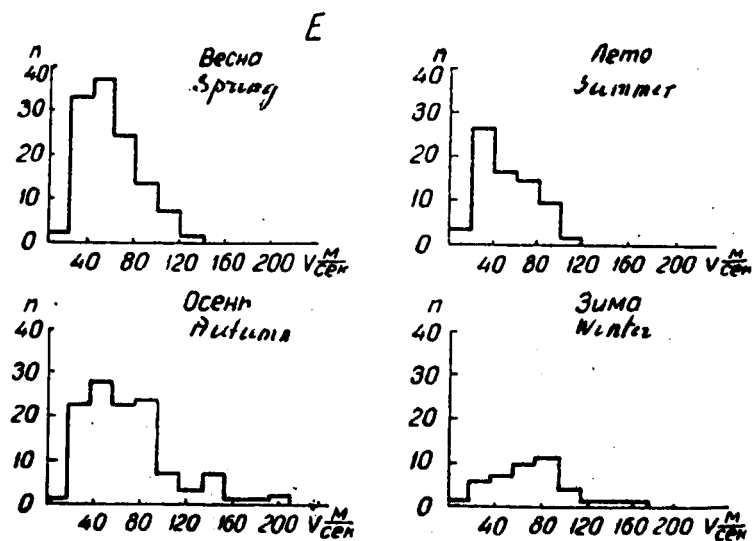


Fig. 5. Histograms of drift velocities' distribution in the E-region of the ionosphere.

Owing to the atmosphere resonance in the meteor zone, the amplitude of velocity components rises to 10–30 m/sec. The daily component often has an amplitude 3 to 8 times smaller. Taking this into account, it is appropriate to conduct a harmonic analysis of the results, available for 12 diurnal hours of the value of the velocity by expanding in Fourier series. The statistics of measurements allow to conduct it by merely uniting quarterly results. Daily variations of the velocity for the O- and X-components in the spring and summer of 1960 are plotted in Fig. 6.

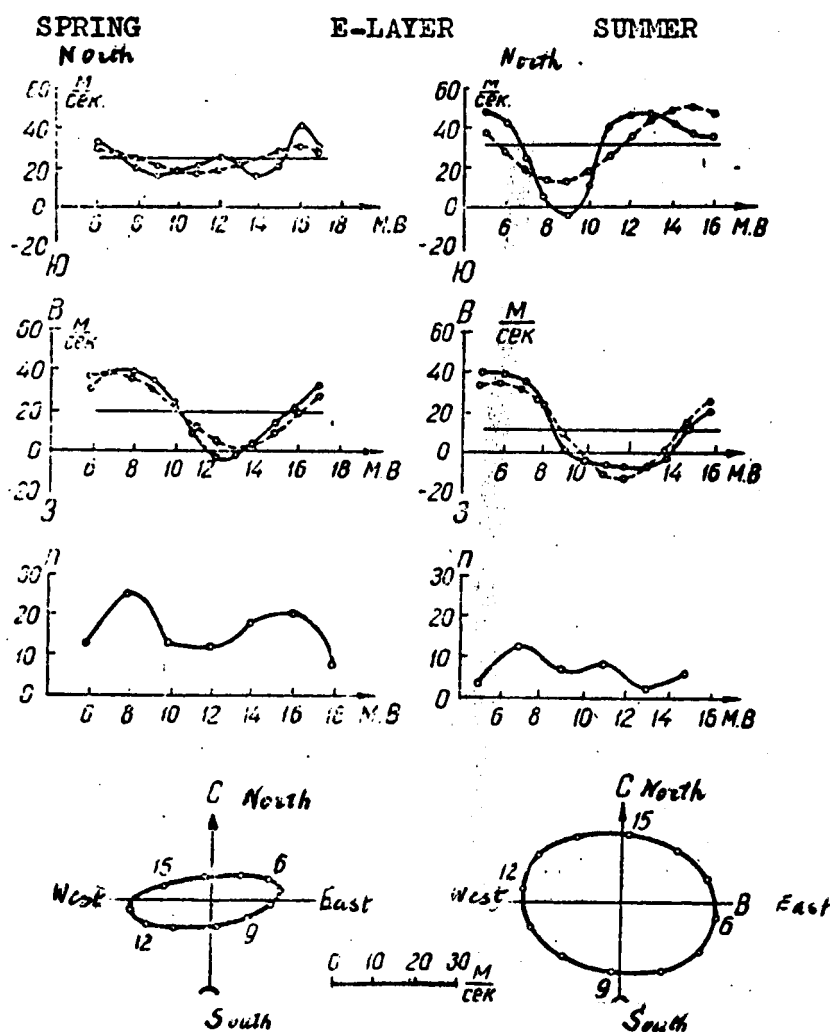


Fig. 6.- Semi-daily component of the drift in the E-region of the ionosphere

3. DRIFT MEASUREMENT AND STATE OF POLARIZATION OF THE RADIOWAVE REFLECTED FROM THE IONOSPHERE.

Polarization investigations have shown that the extraordinary component at Khar'kov latitude is absent in daytime to about 3 mc frequency with the same probability as to the frequency of 2.4 mc/s [2]. Starting from 3 mc, the probability of extraordinary component's appearance increases, and from about 4 mc, this component is often greater by amplitude than the ordinary one. It must then be noted, that the reflections from the E-layer often contain simultaneously the O- and X-components. Characteristic peculiarities in their behavior could be indicated so as to recognize those cases. Thus, the quasi-period of amplitude fluctuations decreases to 2 - 4 sec, while the quasi-period of the amplitude fluctuations of one component, reflected from the E-layer, is of the order of 6 - 14 sec, and by its shape, the fading reflection envelope suggests a sine curve.

A reliable recognition of the interference fading can be made with the help of an additional antenna, similar to drift antenna, which is placed at the same spot with either of the drift antennas and oriented at 90° to the latter. Then, in the presence of interference fading, signals from the main and additional antennas will fluctuate with a certain temporal shift, which is conditioned by the rotation of the polarization ellipse.

In order to investigate the drift at any frequency, it was recommended to use circular-polarization antennas. However, O- and X-components are often present in reflections from the E-layer simultaneously, with nearly the same amplitudes and with quite unstable polarization parameters. That is why the total suppression of either of the components is possible only during 10 - 60 sec. The utilization of sufficiently complex circular-polarization antennas, whose tuning is moreover made difficult on account of the fact, that the polarization

of waves reflected from the ionosphere is, as a rule, elliptical, and besides, the ellipse parameters vary still more in the course of the day, is apparently inappropriate.

*** THE END ***

Translated by ANDRE L. BRICHANT
under Contract No. NAS-5-2078
15 January 1964.

REFERENCES

- [1].- V. P. DOKUCHAYEV.- Izv. A. N. SSSR, ser. geofiz., 5, 183, 1959.
[2].- V. I. TARAN.- Variation of the Drift in the Ionosphere with simultaneous investigation of the state of polarization. (Izmereniye dreyfa v ionosfere s odnovremennym issledovaniyem sostoyaniya polyarizatsii). Issl. Neodnorod. v ionosfere.- Izd-vo A. N. SSSR, M., 1960.

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